
SECTION 15891 - METAL DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 in wg (500 Pa) to plus 10 in wg (2500 Pa) water gage.

1.2 DEFINITIONS

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
 - 1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
 - 2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.3 SUBMITTALS

- A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:
 - 1. Duct Liner.
 - 2. Sealing Materials.
 - 3. Fire-Stopping Materials.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.5 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA Standards:
 - 1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

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- B. SMACNA Compliance: Comply with applicable standards of the Sheet Metal and Air Conditioning Contractors National Association, Inc. - latest edition.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Sheet Metal, General: Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.
- B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
- C. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish where ducts are exposed to view, and mill finish for concealed ducts.
- D. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts.
- E. Tie Rods: Galvanized steel, 6 mm minimum diameter for 915 mm length or less; 9 mm minimum diameter for lengths longer than 915.

2.2 DUCT LINER

- A. General: Comply with NFPA Standard 90A and TIMA Standard AHC-101.
- B. Materials: ASTM C 1071, Type II, with coated surface exposed to airstream to prevent erosion of glass fibers.
1. Thickness: 1" (25 mm).
 2. Density: 1 1/2 lb/ft³ (24 Kg/m³).
 3. Thermal Performance: "K-Factor" equal to 0.16 (0.28).
 4. Fire Hazard Classification: Flame Spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM C 411.
 5. Liner Adhesive: Comply with NFPA Standard 90A and ASTM C 916.
 6. Mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50 lb. (220 N) tensile dead load test perpendicular to the duct wall.
 - a. Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8" (.3 mm) into the airstream.

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- b. Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

2.3 SEALING MATERIALS

- A. Joint and Seam Sealants, General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.
- B. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.
- C. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 75 percent solids.
- D. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.3 FIRE-STOPPING

- A. Fire-Resistant Sealant: Provide one-part elastomeric sealant formulated for use in a tough penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
1. "Dow Corning Fire Stop Sealant"; Dow Corning Corp.
 2. "3M Fire Barrier Caulk CP-25"; Electrical Products Div. /3M.
 3. "RTV 7403"; General Electric Co.
 4. "Fyre Putty"; Standard Oil Engineered Materials Co.

2.4 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4" (100 mm) thick.
- B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
1. Straps and Rod Sizes: Conform with Table 4-1 in SMACNA HVAC Duct Construction Standards, 1985 Edition, for sheet steel width and gage and steel rod diameters.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.

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1. Where galvanized steel ducts are installed, provide hot-dipped-galvanized Steel shapes and plates.
 2. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

2.5 RECTANGULAR DUCT FABRICATION

- A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.
 1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
 2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discoloration's.
- B. Static Pressure Classifications: Supply air duct systems between air handling units and vav or cv boxes shall be constructed to 4 in. w.g. (1000 Pa) pressure classification. All other ductwork shall be constructed to 1 in. w.g. (250 Pa) pressure classification.
- C. Crossbreaking or Cross Beading: Crossbreak or bead duct side that are 19" (475 mm) and larger and are 20 gage or less, with more than 10 sq. ft. (0.93 sq. m.) of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

2.7 RECTANGULAR DUCT FITTINGS

- A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 1985 Edition, Figures 2-1 through 2-10.
- B. Install turning vanes in all square elbows of supply, return, and exhaust air systems unless otherwise noted or indicated on drawings.

2.8 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.
- B. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.
- C. Butt transverse joints without gaps and coat joint with adhesive.
- D. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

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- E. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.
 - F. Secure liner with mechanical fasteners 4" (100 mm) from corners and at intervals not exceeding 12" (300 mm) transversely around perimeter; at 3" (75 mm) from transverse joints and at intervals not exceeding 18" (450 mm) longitudinally.
 - G. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:
 - 1. Intervals of lined duct preceding unlined duct.
 - H. Terminate liner with duct buildouts installed in ducts to attach dampers, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire damper sleeve through fire separation.

2.9 ROUND AND FLAT OVAL DUCT FABRICATION

- A. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 ft. (3600 mm).
- B. Round Ducts: Fabricate round supply ducts with spiral lockseam construction, except where diameters exceed 6 ft (1800 mm). Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.
- C. Flat Oval Ducts: Fabricate flat oval supply ducts with standard spiral lockseams (without intermediate ribs) or with butt-welded longitudinal seams in gages listed in SMACNA "HVAC Duct Construction Standards," Table 3-4.

2.10 ROUND AND FLAT OVAL SUPPLY FITTINGS FABRICATION

- A. 90-Degree tees, Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 1985 Edition, Figures 3-4 and 3-5 and with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.
- C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:
 - 1. Mitered Elbows: Fabricate mitered elbows with welded construction in gages specified below.

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- a. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," Table 3-1.
 - b. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 in wg (500 Pa) to plus 2 in wg (500 Pa):
 - 1) 3" to 26" (75 to 650 mm): 24 gage.
 - 2) 27" to 36" (675 to 900 mm): 22 gage.
 - c. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 500 Pa to 2500 Pa:
 - 1) 3" to 14" (75 to 350 mm): 24 gage.
 - 2) 15" to 26" (375 to 650 mm): 22 gage.
 - 3) 27" to 48" (675 to 1200 mm): 20 gage.
 - d. Flat Oval Mitered Elbows: Solid welded and with the same metal thickness as longitudinal seam flat oval duct.
- 2. Round Elbows - 8" (200 mm) and Smaller: Die-formed elbows for 45- and 90- degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2" (13 mm) diameter (e.g. 3 1/2" and 4 1/2" (90 and 115 mm)) elbows with gored construction.
 - 3. Round Elbows - 5" through 14" (225 Through 350 mm): Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations of 1/2" (13 mm) diameter (e.g. 5 1/2" and 6 1/2" (140 and 165 mm)) elbows with gored construction.
 - 4. Round Elbows - Larger Than 14" (350 mm) and All Flat Oval Elbows: Gored Elbows, except where space restrictions require a mitered elbow.
 - 5. Die-Formed Elbows for Sizes Through 4" (200 mm) and All Pressures: 20 gage with 2-piece welded construction.
 - 6. Round Gored Elbows Gages: Same as for nonelbow fittings specified above.
 - 7. Flat Oval Elbows Gages: Same as longitudinal seam flat oval duct.
 - 8. Pleated Elbows Sizes Through 14" (350 mm) and Pressures Through 10 in wg (2500 Pa): 26 gage.

2.11 ROUND TAKEOFFS FROM RECTANGULAR DUCTS

- A. Provide factory fabricated high efficiency fittings with a rectangular opening in the main duct, 45 square to round transition and a single blade damper with locking quadrant in the round connector.

2.12 SHOWER ROOM EXHAUST AND RETURN DUCTS

- A. General: Except as otherwise indicated, fabricate exhaust and return ducts from rooms containing showers with aluminum sheets in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-14 through 1-16, including associated details. Conform to the requirements in the

referenced standard for metal thickness, reinforcing types and intervals, tie rod applications and joint types and intervals.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

- A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated in the equipment schedule. Install ducts with the fewest possible joints. Use fabricated fittings for all changes in directions, changes in size and shape, and connections. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- B. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- C. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Provide clearance of 1" (25 mm) where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any. Install insulated ducts with 1"(25 mm) clearance outside of insulation.
- D. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- E. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- F. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- G. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and cut or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1 1/2" (40 mm).
- H. Provide temporary cover over duct openings during construction to keep duct interior clean.
- I. Connect round ducts to rectangular ducts with high efficiency 45° tap fittings. Seal fitting connection to rectangular duct with duct sealer.

3.2 SHOWER ROOM EXHAUST DUCTS

- A. Install ducts from rooms containing showers pitched up in direction of air flow so moisture drains back to air inlet. Connect air inlet grille, or register so moisture drains out through openings in face.

3.3 SEAM AND JOINT SEALING

- A. General: Seal duct seams and joints as follows:
 - 1. Pressure Classifications 2" wg (500 Pa) and Greater. All transverse joints, longitudinal seams, and duct penetrations.
 - 2. Pressure Classification Less than 2" wg (500 Pa): Transverse joints only.
- B. Seal externally insulated ducts prior to insulation installation.

3.3 HANGING AND SUPPORTING

- A. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
- B. Support horizontal ducts within 24" (600 mm) of each elbow and within 48" (1200 mm) of each branch intersection.
- C. Support vertical ducts at a maximum interval of 16 ft (4800 mm) and at each floor.
- D. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicted.

3.4 CONNECTIONS

- A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 15 Section "Duct Accessories," except where fans have internal vibration isolation.
- B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-7 and 2-8 except use 45 degree entry for branch connections. Straight tap fittings are not acceptable.
- C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-16 through 2-18.
- D. Terminal Units Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figure 2-19.

3.6 FIELD QUALITY CONTROL

- A. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.

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- B. Conduct test on spiral duct variable air volume systems at static pressures equal to 1.5 times the maximum design pressure of the system or the section being tested.
 - C. Determine leakage from entire system or section of the system by measuring airflow into the system.
 - D. Maximum Allowable Leakage: as described in ASHRAE 1989 Handbook, "Fundamentals" Volume, Chapter 32, Table 6 and Figure 10. Comply with requirements for leakage classification 3 for round and flat oval ducts.
 - E. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

END OF SECTION 15891